Active Project (2015 - 2017)

>1,000 W/kg Rad-Hard, High-Voltage PV Blanket at < $50/W IMM Cell Cost, Phase II Project

SBIR/STTR Programs | Space Technology Mission Directorate (STMD)

ABSTRACT

The innovation is a new Stretched Lens Array (SLA) with a thinner, lighter, more robust Fresnel lens (with thin glass or polymer superstrate or embedded aluminum mesh). The new lens enables a blanket-level specific power > 1,000 W/kg, including lenses, PV cell circuit (including cells, encapsulation, high-voltage insulation, and heavy radiation shielding), and waste heat rejection radiator. The new SLA array is cost-effective, with the most expensive array cost element, the IMM solar cell, contributing only $50/W to the array cost. The new lens is novel in configuration, enabling single-axis tracking for the array even in the presence of large beta angles (e.g., 50 degrees) between the array and the sun. For future high-power arrays (e.g., > 100 kW), including Solar Electric Propulsion (SEP) missions, the new SLA will offer a unique combination of high efficiency (e.g., >35%), ultra-low mass, high-operating voltage (e.g., >300 V), and low cost. SLA technology is a direct descendant of the SCARLET array used to power NASA's Deep Space 1 SEP mission in 1998-2001. SLA recently completed a flight test on TacSat 4 in a very high radiation orbit, and the lessons learned from TacSat 4 led to the new SLA, the subject of this proposal. The new SLA is scalable to multi-hundred-kW array sizes using blanket deployment and support platforms such as DSS's Roll-Out Solar Array (ROSA). The new SLA will typically operate at 4X concentration, saving substantially on solar cell area, cost, radiation shielding mass, and dielectric isolation mass. The new SLA will enable the early use of state-of-the-art cells, such as inverted metamorphic (IMM) cells with 4 or 6 junctions, and will enhance the production capacity of cell vendors (e.g., 100 kW per year of 1 sun cells = 400 kW per year of 4X cells). The feasibility of the new SLA was firmly established in Phase I, and fully functional prototype hardware will be developed and tested by MOLLC, DSS, SolAero-Emcore, and CFE in Phase II.

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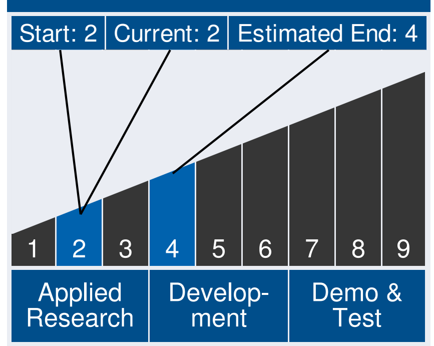
Technology Maturity



Management Team

Program Executives:

- Joseph Grant
- Laguduva Kubendran

Continued on following page.

ANTICIPATED BENEFITS

To NASA funded missions:

Potential NASA Commercial Applications: The new SLA will apply to a wide range of NASA missions, most of which use solar power. The new SLA's superior attributes include scalability to high power, radiation hardness at low mass penalty, reliable high-voltage operation, outstanding power metrics (specific power, areal power density, and stowed power volume), high beta-angle tolerance, and low cost per Watt. These attributes will be especially important for high-power Solar Electric Propulsion (SEP) missions. The high unit cost (e.g., >$10/sq.cm.) of advanced multi-junction solar cells (e.g., IMM cells), may make conventional one-sun solar arrays too expensive for very high-power NASA missions, such as, for example, 300-600 kW SEP tugs to carry large amounts of cargo from low earth orbit (LEO) to GEO, the Earth-Moon Lagrange Points, lunar orbit, Mars orbit, or beyond. For such high-power missions, the new SLA could be mission-enabling because of its much lower cost per Watt, combined with its superior performance attributes, compared to one-sun arrays. Because of its typical 4X concentration, the new SLA also offers much better low-intensity, low-temperature (LILT) performance than one-sun arrays for outer planet missions. The new SLA is also high-temperature-capable, allowing inner planet missions or slingshot trajectories to the outer planets. Potential NASA customers of the new SLA therefore include the Space Technology Directorate, the Science Directorate, and the Human Exploration and Operations Directorate.

To the commercial space industry:

Potential Non-NASA Commercial Applications: The new SLA will apply to a wide range of non-NASA space missions, most of which use solar power. The new SLA's superior attributes include specific power (W/kg), stowed power density (kW/cu.m.), areal power density (W/sq.m.), high-voltage operation, radiation hardness, high sun-pointing tolerance, and low cost per Watt, all

Management Team *(cont.)*

Program Manager:
- Carlos Torrez

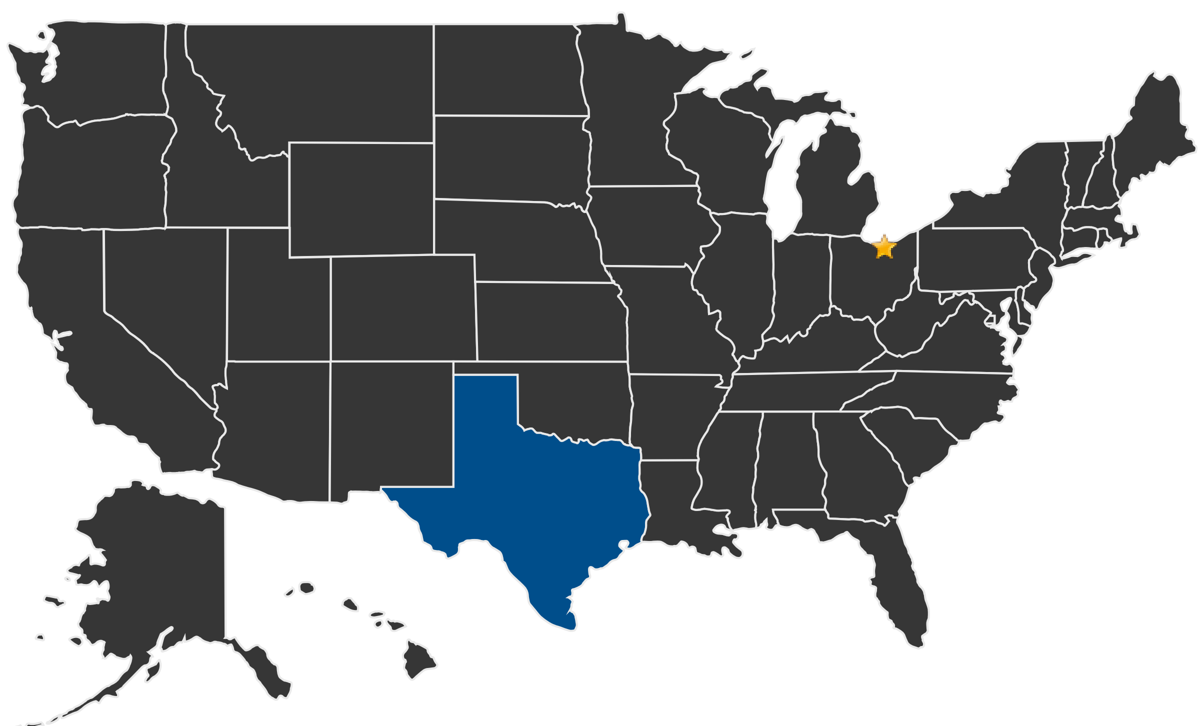
Principal Investigator:
- MARK O'NEILL

Technology Areas

Primary Technology Area:
Space Power and Energy Storage (TA 3)
└ Power Generation (TA 3.1)
  └ Solar (TA 3.1.3)
    └ High-Temperature, Radiation-Tolerant Photovoltaic Blankets (TA 3.1.3.8)

critical to non-NASA customers including established space companies (e.g., Boeing, Lockheed-Martin, Space Systems Loral, Orbital Sciences, et al.), the U.S. DOD (USAF, MDA, et al.), and newer entries into the space business (e.g., Planetary Resources, Bigelow, Ad Astra Rocket Company, SpaceX, et al.). The U.S. DOD is particularly interested in rad-hard arrays, which led them to fund the SCARLET array that flew on Deep Space 1 in 1998-2001 and the Stretched Lens Array Technology Experiment (SLATE) which flew on TacSat 4. The new SLA will offer excellent rad-hardness as well as hardness against other potential threats (e.g., ground-based lasers), and will be more widely applicable to more DOD missions with its new high-beta-angle-tolerance. The new SLA will also be ideally suited to Solar Electric Propulsion (SEP) missions, including orbit-raising (e.g., LEO-to-GEO for communication satellites), asteroid mining (as planned by Planetary Resources), drag compensation (for inflated space stations in LEO as planned by Bigelow), and multi-hundred-kW spacecraft (as planned by Ad Astra). Our team (DSS, SolAero-Emcore, QioptiQ, and CFE) looks forward to Phase II.

U.S. WORK LOCATIONS AND KEY PARTNERS



U.S. States With Work

Lead Center:
Glenn Research Center

Other Organizations Performing Work:

- Mark O'Neill, LLC (Keller, TX)

PROJECT LIBRARY

Presentations

- Briefing Chart
  - (http://techport.nasa.gov:80/file/17888)

DETAILS FOR TECHNOLOGY 1

Technology Title

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